PARTICLE-INDUCED OXIDATIVE DAMAGE FROM EXPOSURE TO AIRBORNE PM2.5 COMPONENTS IN THE VICINITY OF HONG KONG LANDFILLS

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Landfills are an essential component of Hong Kong's waste management strategy. With a geographically small size and a large population it is inevitable that many residents will live proximal to landfill sites, and this has raised public concerns about landfill emissions causing low birth weights, cancer, neurological diseases, nausea, and hospitalization of diabetics. This project has collected, physico-chemically characterise, and determined the potential bioreactivity of landfill-derived PM2.5 particulates.

Many studies have demonstrated the health risks posed by landfill sites (Koshy et al., 2009), but unfortunately there is lack of investigation in the bioactivity of PM2.5 from municipal landfill sites in Hong Kong. This study has investigated the physicochemical characteristics of PM2.5 samples collected from locations near Municipal Solid Waste (MSW) landfill sites. We determined the oxidative stress of PM2.5 samples from their generation of reactive oxygen species. We determined the relationship between physical and chemical characteristics of PM2.5 and their bioreactivity from particles collected near to the landfill sites and in downwind urban sites.

Five sampling sites were selected for this study. Two sites adjacent to the landfill areas, Two urban sites in a mixture of residential and commercial areas, and one sampling site is in a remote area far removed from any anthropogenic activities. The PM2.5 samples were collected simultaneously at all sites with URG PM2.5 samplers. Wind and real-time PM2.5 monitors were installed at two locations in proximity to the landfill sites in order to determine diurnal variations of particulate level, wind speed and direction. Twenty-four hours integrated PM2.5 samples were collected in winter (December to March, 2014-15) and summer (July to November, 2015) in every 3 days intervals. Samples were weighed to a 1 μg precision for the mass concentration measurements. Field emission scanning electron microscope (FESEM) analysis was used for particle imaging. Total metal concentrations were analysed using inductively coupled plasma mass spectrometry (ICP-MS). Ion chromatography (IC) was employed for water-soluble inorganic ions analysis. Organic carbon (OC) and elemental carbon (EC) were analysed by thermal optical reflectance. Thermal desorption-gas chromatography-mass spectrometry (TD-GC/MS) was used for polycyclic aromatic hydrocarbons (PAHs) analysis. A plasmid scission assay (PSA) was used to determine the capability of each sample to induce plasmid DNA damage. Statistical analysis was performed using SPSS 21.0 software. The average PM2.5 concentrations were generally higher in winter than summer at all locations and significant differences between seasons were observed at the landfill sites. The average concentrations of most chemical species demonstrated summer minimum and winter maximum. The contributions of OC and EC in PM2.5 in winter are in a range of 17.2-29.1 and 4.4-5.0%, respectively. However, the contributions of OC is lower in summer. The NO3-, SO42- and NH4+ are the three most abundant inorganic ions, with sulphate contributed in a range of 6.6-42.3 % in PM2.5 in winter. The amount of damage to the plasmid DNA induced by PM2.5 varied in a range of 24-92 % and 27-96 % in winter and summer, respectively. The DNA damage in summer were higher than winter in all locations

High PM2.5 levels were observed during daytime downwind from landfills. Significant associations were observed between DNA damage and heavy metals/PAHs in summer. Emissions from landfill-related machinery are potential important particle sources. No significant associations were observed between DNA damage and landfill particles, which indicates that PM2.5 loading from other regional sources was an important factor for DNA damage.

[1] Koshy, L., Jones, T. P., Berube, K. A., 2009. Characterization and bioreactivity of respirable airborne particles from a municipal landfill. Biomarkers 14 (S1), pp. 49-53.